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ABSTRACT

This survey was conducted to identify the types and numbers of computer and electronic data processing (EDP) personnel that are needed in Indiana, together with their knowledge and experience requirements. Over 1,000 businesses and government agencies received questionnaires requesting information on: (1) type of EDP operation and system, (2) hardware, (3) functions/utilization, (4) software, (5) manpower, (6) level of understanding required, and (7) curriculum objectives. On the basis of 432 responses, conclusions are presented regarding the kinds of equipment and computer languages in use and their expected future importance. The educational program objectives for the associate and bachelor's degree in computer technology are also identified and rank-ordered. (BH)

ED 061 457

Computer and Electronic Data Processing Manpower and Educational Requirements in Indiana

School of Technology

Manpower Report 71-3

21 September 1971

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COMPUTER
and
ELECTRONIC DATA PROCESSING (EDP)
MANPOWER REQUIREMENTS IN INDIANA

PREFACE

The computer and EDP equipments are among man's most complex industrial products and they are being improved continuously. They are being made in increasing quantity by mass production techniques. Concurrently, there is a rapid expansion occuring in computer and EDP systems applications in business, government and industry. There has been great emphasis on systems which store, retrieve, compute and print out large amounts of data efficiently and economically. Complex problems are now being solved accurately and quickly. A further extension of computer applications is fast becoming more widespread -- that of monitoring and controlling industrial processes and operations. All indications are that there will be many more developments and applications in the future.

However, computers and EDP equipments are powerless by themselves to analyze problems; design systems; acquire, store and process data, and report or print out information without detailed instructions and expert service. In fact, it is the human factor that now sets limits on the applications, usefulness and effectiveness of these equipments below their optimum capabilities.

Most simply stated, the critical issue in the computer field is people: the need for skilled personnel at a variety of occupational levels.

This study is an attempt to identify the types and numbers of computer and EDP personnel that are needed together with their knowledge and experience requirements.

The kinds of equipments and operating systems in use with related computer languages and their present and future importance are documented. The educational program objectives for the associate and bachelors degree in computer technology are also identified and rank-ordered.

The team approach, comprised of representatives of business, government, industry and education, as used in this study, has provided a better identification of the manpower and educational requirements.

The data in this study, and application of the findings and recommendations should:

Enable educators to improve their curricula, equipment choices and services to Indiana citizens and employers.

Result in improved educational and training opportunities to many youths and adults in preparation of challenging and rewarding careers.

Provide employers with personnel who are well prepared to fill a responsible job or position and have the potential to improve, and who will enhance the operations and profits of their firms.

Assist computer and EDP users and equipment manufacturers with information useful to their planning.

It now remains to each of us to study this report, and do the things needed, to take advantage of the data and findings.

Prof. J. P. Lisack

COMPUTER and ELECTRONIC DATA PROCESSING MANPOWER REQUIREMENTS in INDIANA

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This manpower study was conducted under the guidance of an advisory committee and others who provided valuable assistance and information. Their cooperation is greatly appreciated.

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CHAPTER I

PURPOSES and DESCRIPTION of the REPORT

1. Purposes

This report was designed to provide current detailed information concerning manpower and educational needs for computer and electronic data processing (EDP) related occupations in Indiana, as well as data concerning related hardware and software. The information is presented to help improve the presently on-going computer technology educational programs at the associate degree and baccalaureate levels. This report should also be useful for planning the training of computer operating and clerical personnel at lower educational levels, as well as for counseling purposes and other applications. Actually, these data up-date and expand the results of a series of studies conducted in 1967 for Indianapolis[1/], Calumet[2/] and Fort Wayne[3/], and in 1968 for Kokomo[4/]. The seven specific purposes of this report are to:

(1) Identify the types of computers, EDP and peripheral equipments, and the operating systems being used by Indiana business and industrial firms, government and educational institutions and hospitals.

(2) Ascertain the present (and projected) principle functions performed (utilization) of these computers and equipments, as well as identify the kinds and trends and changing importance of various computer languages and software.

(3) Determine the present and projected manpower situation (quantitative, experience and educational level requirements) for computer and EDP managers and supervisors, analysts, programmers, operators and recorders.

(4) Obtain opinions as to the levels of understanding needed in specific subject areas, for the occupations listed in (3) above.

(5) Determine the relative rank order in importance of curriculum objectives for the two-year Associate in Applied Science and the Bachelor of Science Degree programs in Computer Technology.

(6) Present the National employment outlook for these occupations.

(7) Formulate conclusions and develop recommendations based on the data and materials in the study.

1/ Refers to number in Selected Bibliography beginning on page 35.

2. Rationale and Methods Used

This study was conducted under the guidance of an advisory committee and advisors made up of representatives from Indiana business and manufacturing firms, banks, hospitals, government and educational institutions. The advice and cooperation of other experts in the field, including appropriate associations, was also obtained. The specific information and data needed to improve computer technology programs were identified and the seven principle purposes of the study (as outlined in Section 1 above) were developed.

It was determined that a broad approach was needed to assure that information was obtained from all appropriate business and industry firms by type, size and geographic (State) coverage, as well as other pertinent organizations. Therefore, the use of a mailed questionnaire was chosen to acquire the extensive data needed. In view of the fact that some firms used their own occupational titles, and data was needed for each occupation, an attachment to the questionnaire was designed containing occupational titles and job descriptions.

A sample copy of the letter of transmittal, questionnaire, and attachment containing these occupational titles and definitions are included with this report as Appendix I.

3. Format on This Report

This first chapter outlines the objectives and purposes of the report, briefly explains the rationale and methods used, and describes the contents of each following chapter. The next chapter describes the survey in more detail; the main parts of the questionnaire and specific questions used, the distribution and the response by selected categories. Chapter Three presents the actual data resulting from the survey and the Findings, Conclusions, and Recommendations are developed in Chapter Four. Materials and data from other sources are included in the last two chapters but are separately identified in each instance. (For example, nation-wide projected employment opportunity data from the U. S. Department of Labor.) Finally, there are a number of appendices and attachments and a Selected Bibliography at the end of the report.

CHAPTER II
COMPUTER and EDP RELATED SURVEY
DESCRIPTION, DISTRIBUTION and RESPONSE

4. The Survey Package

A seven part questionnaire was designed, pilot tested, then printed for wide distribution. An attachment of occupational titles and definitions was fastened to the questionnaire to assure better understanding. A letter of transmittal was used explaining the purposes of the study and asking for cooperation. A sample copy of the "survey package" is included as Appendix 1 to this report. (A franked, self-addressed envelope was included in the package.)

5. The Questionnaire

The questionnaire instrument was divided into seven sections (following the usual identification information concerning the respondent, his title, firm and address). Each section was designed to obtain certain inter-related data considered to be useful in the planning of educational and training programs for computer and EDP related occupations at all levels. The title and brief description of each section follows:

SECTION I, TYPE of EDP OPERATION and SYSTEM. The respondent was asked to identify the area(s) of operations his return represented (e.g. business, process control, scientific and/or engineering, etc.) and the firm's basic types of EDP systems.

SECTION II, HARDWARE. The computer(s) manufacturer, model, memory size and operating systems were recorded.

SECTION III, FUNCTIONS/UTILIZATION. The present and anticipated computer applications were checked (e.g. accounting/bookkeeping, sales anlaysis/marketing studies, scientific or engineering, etc.).

SECTION IV, SOFTWARE. This section provided information for three points: (1) What specific languages and software were being used, (2) The percentage of time (analysis & programming) spent in each, and (3) Whether the importance of each was increasing, no change, or decreasing.

SECTION V, MANPOWER. Twelve computer/EDP related occupations were listed (with descriptions of each attached to the questionnaire). Both quantitative and qualitative information was requested as follows: (1) The number now employed in each occupation, the present number of job openings and estimate of future needs; and (2) The minimum hiring requirements for each in terms of educational level and previous experience (in years and with specific EDP equipments).

SECTION VI, LEVEL OF UNDERSTANDING REQUIRED. Thirty courses were arranged under the three basic subject areas of Computer or EDP, Business or Technical Support, and Mathematics and Other. The respondent was asked to indicate the level of understanding generally needed for specific occupations. (A four point scale was used based on Bloom's Taxonomy in the Cognitive Domain.)

SECTION VII, CURRICULUM OBJECTIVES. Twelve objectives were listed for each of the Associate in Applied Science (2 yr.) and Bachelor of Science computer technology programs. A request was made to rank order (1st, 2nd, 3rd, etc.) each set of objectives.

In addition to the separate sections, the questionnaire provided room for comments and other write-ins.

6. Distribution

These survey packages were mailed to 1,100 selected addressees in eight major industry groups as follows: (1) manufacturing firms; (2) service firms including transportation, communications, electric, gas and sanitary services; (3) wholesale and retail trade establishments; (4) finance, insurance and real estate; (5) other miscellaneous business services which include accounting firms, consultants and service bureaus; (6) medical and health services; (7) educational institutions; and (8) government offices.

In addition to selecting representative firms from each industry group, efforts were made to obtain representation from each of the major Purdue University Administration Regions as follows: (1) The Calumet Region (Lake County), (2) North Central Region (Michigan City and South Bend area), (3) Northeastern Region (Fort Wayne area), (4) Lafayette Region, (5) Central Region (Indianapolis area) and (6) Southern Region.

7. Response

There were 432 questionnaires returned from the 1,100 survey mail-outs, a response rate of nearly 40 per cent. There were 225 of these returns from respondents who identified some form of computer and/or EDP operations; the other 207 returns reported there were no such operations at their locale. Of these 207 firms, 45 were in wholesale or retail; 42 were finance, insurance or real estate; 37 were hospitals or health services; 23 were manufacturing firms; 21 were in transportation or utilities, with the remaining 39 in a variety of other activities.

The next chapter shows the results and analyses of the 225 respondents having computer or EDP operations, arranged in the seven major sections of the questionnaire as described in Section 5.

Data in this report are shown for the entire State. However, computer print-outs for each of the seven sections of the questionnaire have been made for those respondents in each of the six geographic regions. These data have been provided to the computer technology section chairman at each regional campus as listed on the Acknowledgement Page of this report.

Also, computer print-outs have been made of responses by industry groups. These data are available at the Office of Manpower Studies, Purdue University SCC-A, Lafayette, Indiana 47907.

CHAPTER III
SURVEY RETURN ANALYSES

This chapter is arranged in the same seven sections used in the questionnaire as described previously. The questions are cited verbatim, followed by the data and a brief discussion.

8. Survey Results and Discussion

SECTION I
Total or Part Operations Locally

Please identify (✓) if your return represents the total (complete) local computer/EDP operation, or a separate and/or autonomous part of the total operation at this location:

		No.	Per Cent
Total	(complete)	192	85%
Part	(separate and/or autonomous)	33	15%
		225	100%

The above data mean that 85% of all respondents reported that the total or complete computer/EDP operations for their firm (the local site) was represented in their response: the other 15% of the returns represented only a part of that firm's activities (e.g. the scientific and engineering activities being physically separated from the personnel & business type operations).

Type of EDP Operations

Please check (✓) the area(s) of operations your return represents:

Functional Area	Returns by Operations: Complete (Total) No.	%	Part (Separate) No.	%	ALL RETURNS No.	%
Business	167	70%	23	71%	190	71%
Process Control	5	2%	1	3%	6	2%
Scientific and/or Engineering	30	12%	3	9%	33	11%
Others*	38	16%	6	17%	44	16%
TOTALS	240	100%	33	100%	273	100%

*Includes: Educational Services 20; Government 6; Medical & Other Health 8; Other Miscellaneous 4

The large majority of firms (71%) reported Business as a functional area of their computer/EDP operations. Scientific and/or Engineering was next (11%).

SECTION I (Continued)

Type of EDP Operation and System

Please identify (✓) your basic type(s) of EDP system:

	Returns by Operations				ALL RETURNS	
	Complete (Total)		Part (Separate)			
	No.	%	No.	%	No.	%
One or more computers at this location	152	51%	13	24%	165	47%
Computer here tied with computer elsewhere	15	5%	9	16%	24	7%
Computer elsewhere with terminal facilities here	13	5%	5	10%	18	5%
Unit record operations	40	13%	6	12%	46	13%
Use of service bureaus or rental of computer time from out-of-house computer operations	27	9%	9	18%	36	10%
Others*	6	2%	3	6%	9	3%
Combination of above	47	15%	8	15%	55	15%
TOTALS	300	100%	53	100%	353	100%

*Includes: Banking-demand deposit system
Government linked system
"shared" computers
Computer here w/terminals elsewhere

More than half the responses from firms having complete (total) computer or EDP operations locally reported they had one or more computers at their location. Understandably, a higher percentage of those firms having part or separate operations locally, reported the use of service bureaus or rentals or that they were tied to computers elsewhere. About 13% of these respondents reported Unit Record Operations.

SECTION II HARDWARE

Please identify computers at your location:

Altogether, respondents reported having a total of 264 computers: nearly half of this total was comprised of various IBM 360 models (128 such computers): there were totals of 179 IBM model computers, 25 Honeywells, 20 NCR's, 16 Burroughs, 15 RCA's, 6 Sperry Rands, and 4 others. Specific models are shown below:

IBM*

360 Models	No.	Other IBM	No.
360/30	40	1130	13
360/20	26	System-3	10
360/50	24	1401	8
360/40	19	370/155	4
360/25	14	All Other	16**
360/65	5		
		IBM TOTAL	179

HONEYWELL* (Includes former G.E.)

Model	No.
120	8
200	5
115	3
G115-(GE)	2
110	2
All Others	5**
TOTAL	25

NCR*

Model	No.
NCR 315	8
Century 100	6
Century 200	5
Century 400	1
TOTAL	20

BURROUGHS*

Model	No.
3500	4
300	2
All Others	10**
TOTAL	16

RCA***

Model	No.
70/45	6
40/15	2
501	2
301	2
All others	3**
TOTAL	15

SPERRY RAND*

Model	No.
9200	2
All others	4**
TOTAL	6

G.E.*** Now part of Honeywell (4 were reported)

OTHERS

(CDC, PRODAC, VARIAN, XDS) 4

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Most of the respondents reported that their operating systems were Disk Operating Systems (DOS) -- there were 172 so identified; a summary of all operating systems that were identified is shown below:

Type Operating System*		Number Reporting
DOS	Disk Operating System	173
OS	COS & DOS & TOS (combinations)	27
COS	Card Operating System	24
TOS	Tape Operating System	17
Others		42
	TOTAL	283

*NOTE: The specific memory size and type of operating system(s) associated with each model computer are shown in Appendix II A and B.

** These models are identified in Appendix II A and B.

*** See special note on next page.

Special Note re G.E. and RCA Discontinuance of the Manufacture of Computers.

RCA

On 17 September, 1971 Mr. Robert W. Sarnoff, Chairman and Chief Executive, reported that RCA had decided to drop out of the general-purpose computer market, and put nearly all of that business up for sale.

Mr. Sarnoff said RCA would continue to develop and make computer-based "specialized data-communications systems" for government and defense, communications networks, and business. He also said RCA Service Co., a division, would continue its "expanding" maintenance program for computers and electronic equipment made by others. 7/

It was reported in an article of THE WALL STREET JOURNAL on 20 September, 1971 7/ that RCA's first commercial computer was the transistorized 501, introduced in 1958. Since then it has made about 1,200 computer installations in the U. S., and 400 to 500 abroad, where it operates through liscensees.

G.E.

Last year, General Electric Company sold the principal parts of its computer business to Honeywell, Inc. The former G.E. computer model numbers were not changed. A problem arises in that some of the users now call their former G.E. computers Honeywell--while others still identify them as G.E. This report has combined the two under Honeywell per the suggestion of Mr. J. A. Oeffinger, a member of the EDP Study Committee. 8/

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AUTHOR'S NOTE: The entire computer industry has been hurt by the effects of the 1970-71 recession. It is noteworthy that replies to the questionnaires indicated some new (anticipated) computer/EDP applications within the next three years and some increases in manpower needs. It is suggested that considering the present economic climate, these response data be considered to represent the lower parameter.

SECTION III FUNCTIONS/UTILIZATION

Please indicate (✓) the present and anticipated computer/EDP applications at your location.

Results were as follows for those answering the question:

Present No.	Present %	Anticipated No.	Anticipated %	Type of Application
184	84%	19	9%	Accounting/Bookkeeping
92	45%	23	12%	Sales Analysis/Marketing Studies
116	56%	35	18%	Inventory Controls/Materials Management
61	29%	36	18%	Production (Planning and Control)
19	9%	38	19%	Real Time Processing (Inc. Process Control)
12	6%	8	4%	Numerical Control
32	15%	14	7%	Scientific or Engineering Studies (includes R & D)
18	8%	38	19%	Decision Models/Simulation
58	28%	60	29%	Information Retrieval
39	20%	7	4%	What Else*

*Educational services: Administration 11 and teaching 5.

Financial area: Payroll 5, budgets and cost control 5, banking 3.

Medical and health 11, statistical services 6, manufacturing 3.

It was stated earlier that the large majority of firms reported "Business" to be the Functional Area of their computer/EDP operations. The above data are consistent with that finding as nearly 85% of the respondents report they are now making Accounting/Bookkeeping type applications; other applications reported by a large percentage of firms include Inventory Control/Materials Management (56%) and Sales Analysis/Marketing Studies (45%) with more firms anticipating these applications. Also anticipated by a noteworthy number of firms are applications in Information Retrieval (29%), Decision Models/Simulation (19%), Real Time Processing (Incl. Process Control) (also 19%), and Production (Planning & Control) 18%.

SECTION IV SOFTWARE

Please check (✓) whether the languages or software you are using are increasing or decreasing in importance; then indicate your estimate of the percentage of your analysis and programming time in each.

Importance is: Increasing (Number)	Importance is: No Change (Number)	Importance is: Decreasing (Number)	Count/Percentage: Total Number Responses	Count/Percentage: % of Respondents N = 175	Language/Software
					COMPILER LANGUAGES
70	36	12	118	67.4%	COBOL
24	35	8	67	38.2%	FORTRAN
15	12	4	31	17.7%	PL/1
24	42	26	92	52.6%	RPG or Report Writer
14[a/]	19[b/]	8[c/]	41	23.4%	Other (e.g. APL, BASIC, ALGOL ...)
Σ 147	144	58	349		
					OPERATING SYSTEMS SUPPORT
44	25	0	69	39.4%	Job Control Lang.
27	18	2	47	26.9%	Software Maintenance
2	5	0	7	4.0%	Other
Σ 73	48	2	123		
28[d/]	55[e/]	26[f/]	109	62.3%	ASSEMBLY LANGUAGES (e.g. EASYCODER, BAL, NEAT ...)
5[g/]	8	3	16	9.1%	SPECIAL PURPOSE LANGUAGES (e.g. SIMSCRIPT, APT ...)
41[h/]	13	1	55	31.4%	SOFTWARE PROGRAM PACKAGES (e.g.Oper. Systems & Application Areas)
Σ 294	268	90	652		

a/ 5 of these were BASIC and 2 were APL
b/ 3 of these were BASIC and 3 were NEAT/3
c/ 3 of these were AUTOCODER
d/ 10 of these were BAL
e/ 13 of these were BAL, 4 were EASYCODER, 3 were ALC and 2 were NEAT
f/ 5 of these were BAL, 3 were EASYCODER and 3 AUTOCODER, and 4 were NEAT
g/ 3 of these were BAL
h/ 5 of these were Application Program Packs, 3 were POWER, 2 were TOTAL

Discussion of Software

The preceding chart shows that the large majority of respondents used Compiler Languages extensively. COBOL was used most frequently (by more than 67% of those answering the questionnaire) and it was identified as increasing in importance by most of those using it. RPG or Report Writer was next highest in use (52.6%) (frequency); of the 92 who reported they used it, 24 said it was increasing in importance, 42 said no change in importance and 26 said it was decreasing in importance. FORTRAN was the third most commonly used Compiler Language (38.2% of those responding) with indications it was increasing in importance.

Assembly Languages were being used by about 62% of the respondents (about 5% fewer than used Compiler Languages). About half of these respondents reported there was no change occurring in the importance of their usage of Assembly Languages; the other half were about evenly divided between those saying there was an increase in importance and those saying there was a decrease in importance.

Operating Systems Support was also used by more than half of those responding: nearly 40% used Job Control Languages and nearly 30% used Software Maintenance. The majority of users in both groups reported these were increasing in importance.

Although only 31.4% of the respondents reported using Software Program Packages, the very large majority of these reported they were decidedly increasing in importance.

———***———

The second part of the question concerning SOFTWARE asked for an estimate of percentage of the analysis and programming time that was spent in each language or software used. More than 160 respondents completed this section -- the results are shown on the following page in two ways:

1. A percentage distribution of the summed percentage time usages by items as reported in the total response (totals 100%), and
2. The average percentage time usage by items for those indicating some percent use of the item.

Percentage of Analysis and Programming Time Spent in Languages and Software

N = 161

Language/Software	PERCENT[1]/ DISTRIBUTION	AVERAGE [2]/ PERCENT	NUMBER RESPONDING
COMPILER LANGUAGES			
COBOL	39.1%	63.1%	95
FORTRAN	6.8	23.3	45
PL/1	2.8	29.1	15
RPG or Report Writer	19.4	43.4	69
Other (e.g. APL, BASIC, ALGOL ...)	4.7	30.6	25
SUBTOTAL	72.8%	45.3%	249
OPERATING SYSTEMS SUPPORT			
Job Control Lang.	2.2%	9.7%	34
Software Maintenance	.5	4.4	16
Other	.8	24.8	5
SUBTOTAL	3.5%	9.5%	55
ASSEMBLY LANGUAGES (e.g. EASYCODER, BAL, NEAT ...)	19.7%	34.2%	88
SPECIAL PURPOSE LANGUAGES (e.g. SIMSCRIPT, APT ...)	.5%	8.4%	8
SOFTWARE PROGRAM PACKAGES (e.g. Oper. Systems & Application Areas)	2.2%	13.1%	25
Other/Unknown/Complement	1.3%	5.3%	38
TOTAL	100.0%	-	-

1. Percent distribution of the total combined time spent by all respondents (161) for analysis and programming in these software areas; (e.g. COBOL -- 39% of the total combined usage times for all respondents is spent in COBOL).

2. Average percents of the item-wize total combined times spent by those respondents utilizing the particular software area; (e.g. COBOL -- for the 95 respondents indicating they used this compiler language, the average percent of time spent in analysis and programming with it was 63%).

Discussion of Analysis and Programming Time Spent in Languages and Software

Looking at the preceding table -

First, it is noteworthy that about 73% of the total overall time spent by the 161 respondents to this question was spent in analysis and programming time using Compiler Languages, with the average percent of time so spent being 45%. COBOL accounts for 39% of the total distribution of time spent with an average percentage use of 63% by those using it. RPG or Report Writer accounts for 19% of the total distribution with an average percent usage by the user of 43%. FORTRAN versions account for 7% with an average use of 23%. As stated earlier, more respondents used Compiler Languages than all other kinds.

Second, about 20% of the overall time spent by the 161 repondents to this question was used in Assembly Languages. The average percent of time spent was 34%. The second largest number of respondents identified usage of these assembly languages.

Finally, the remaining categories of Operating Systems Support, Software Program Packages, Special Purpose Languages, and Other/ Unknown/Complement accounted for the remaining 7% of the total overall time spent by the 161 respondents to the Software items in the questionaire.

V. MANPOWER

Please indicate your manpower needs and minimum hiring requirements for those occupations applicable to your organization.

n = 225

Occupation**	How many personnel do you: Now have employed	Now have job openings for	Estimate will be needed for the next 3 years	What are your **minimum** hiring requirements: Educational Level (Enter code number 1 thru 5*)	Previous Experience: In Years (0 For None)	With specific EDP equipment: Yes	No
Manager or Director	251	1	70	3.39	5.2	74	70
Systems Engineer, EDP	52	3	42	3.31	3.8	24	13
Business Systems Analyst	305	6	201	2.71	3.1	37	47
Systems Programmer	230	11	116	2.43	2.4	58	39
Business Programmer	574	24	373	2.28	1.6	39	60
Technical Programmer	74	3	41	2.92	2.3	8	21
Junior Programmer (Detailer)	103	6	87	1.84	.8	14	39
Computer-Peripheral Equipment Operator	738	12	316	1.33	.9	55	71
Unit Record Equipment Operator	159	2	72	1.05	.4	12	22
Key-punch or Verifier Operator	1,348	26	529	1.15	.8	45	69
Other Data Recorders	107	2	56	1.15	.4	5	25
Which Other (e.g. supervisor,*** EDP trainer, librarian)	283	10	114	2.05	2.1	26	46
Sub-totals	4,226	106	2,017				
TOTAL	4,329						

*Code: 1 – High school graduate
2 – Some post-high school training – but less than two years (non-collegiate)
3 – Associate degree (2 years college)
4 – Bachelors degree
5 – Masters or higher degree

**For Occupational Definitions, see Attachment A.

*** Includes: 44 Supervisors (of operations, of programming, of systems, etc.); 19 Directors with various titles; 14 Librarians; 13 Control & Audit Clerks; 10 Instructors/Trainers; plus sales personnel, coordinators, a variety of Special Operators, etc.

NOTE: No expansion to the universe of all possible respondents throughout the State was made. A rough estimate would be that the survey returns represent approximately 40 per cent of the total employment in the industries surveyed. Therefore, a coefficient of expansion of 2.5 would have to be applied to obtain a rough estimate of the total manpower picture.

Discussion of Manpower

The preceding chart shows there were a total of 4,329 jobs in computer and EDP related occupations reported by the 225 respondents. Only 106 of these jobs were vacant---fewer than $2\frac{1}{2}$ per cent (in the 1967 surveys of these jobs,[1/] [2/] [3/] there was an average of 9.3% reported job vacancies). The present flat state of the economy and tight labor market are definitely reflected in these data.

The need for 2,017 personnel for the next three years was reported in this present study, which is 46.5% of present jobs, this is fairly consistent with the 41% reported in the 1967 survey.

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The distribution of jobs in this 1971 study can be compared with those determined in the 1967 surveys.[1/] [2/] [3/] The results are shown below:

Occupational Group	Percent Distribution 1967	1971	Total No. of Jobs Reported, 1971
Manager/Director	7.5%	7.1%	307
Analyst/Programmer	31.9%	30.8%	1,333
Operator/Clerical	57.8%	55.3%	2,394
Others	2.8%	6.8%*	295
TOTAL	100.0%	100.0%	4,329

* Includes some jobs related to management, supervision, and programming.

It would appear from the above that the occupational distribution has not changed measureably since 1967.

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If an assumption is made that the manager/director and systems engineer activities are best performed by a person at the baccalaureate level (as recorded previously), and applying a coefficient of expansion of 2.5 to the respondents to reflect the universe of all State requirements, it is calculated that approximately 125 of such graduates may be needed each year. (Applying reported estimates of projected manpower needs as described on the next page.)

Likewise, assuming that analysis and programming may be best accomplished by an associate degree graduate and expanding to the State universe, it is calculated that approximately 850 such graduates may be needed each year. In addition, approximately 120 personnel are needed with some college education for other supervisory, training, library and other functions.

Applying the same type of calculations, and assuming that computor operations and related clerical functions are best performed by those having some post-high school vocational training or education (but less than a two-year associate degree), the annual requirements approximate 1,000 per year.

Discussion of Manpower (Cont'd)

If the numbers of jobs reported by respondents as being currently vacant are added to one-third of their estimated needs for the next three years, an approximation of the annual recurring needs for each occupation may be derived. Applying the 2.5 expansion coefficient to expand response results to the State universe results in the following table:

N = 225

Occupation	Estimate of Annual Recurring Needs: Reported by Respondents — Number	Reported by Respondents — % Distribution	Expanded to State Universe
Manager or Director	25	3.4%	65
Systems Engineer, EDP	15	2.0%	40
Business System Analyst	70	9.5%	175
Systems Programmer	45	6.1%	120
Business Programmer	135	18.3%	340
Technical Programmer	15	2.0%	40
Junior Programmer	35	4.7%	90
Computer or Peripheral Equipment Operator	115	15.5%	290
Unit Record Equipment Oper.	30	4.0%	80
Key-Punch or Verifier Oper.	190	25.7%	475
Other Data Recorders	20	2.7%	50
Others (Supervisor, Librarian etc.)	45	6.1%	120
	740	100.0%	

The rank order of the five occupations having the highest annual recurring requirements are:

1st	Key-Punch or Verifier Operators	---	475
2nd	Business Programmers	---	340
3rd	Computer or Peripheral Equipment Operators	---	290
4th	Business System Analysts, and	---	175
5th	Systems Programmers.	---	120

VI. LEVEL OF UNDERSTANDING REQUIRED

To what extent are understandings generally needed for each occupation?
Enter the appropriate number for each item according to the following scale:

0 – None
1 – Some Exposure (Leave blank if not applicable.)
2 – Basic Understanding
3 – Thorough Knowledge

N = 178 $\bar{x}$ *

BASIC SUBJECT AREA	Occupations: Managers & Directors	Analysts	Programmers	Operators
COMPUTER OR EDP				
Documentation Procedures	2.5	2.9	2.8	1.8
Unit Record Operations	1.9	1.8	1.7	2.0
Sort & Merge Techniques	1.8	2.3	2.4	1.6
Storage & Retrieval Techniques	2.0	2.6	2.6	1.2
Data Communications	2.0	2.3	2.0	1.0
Real Time Processing (including process control)	1.7	1.9	1.6	.8
Hybrid Computers	1.1	1.0	.8	.3
Operating System Techniques	1.9	2.3	2.3	1.8
Systems Analysis/Programming	2.3	2.8	2.6	.7
General Programming Techniques	2.2	2.5	2.9	.8
Specific Programming Languages	1.7	2.3	2.8	.6
Simulation/Decision Models	1.6	1.9	1.2	.3
Other (identify)	1.2	1.2	.9	.4
BUSINESS OR TECHNICAL SUPPORT				
Economics	2.0	1.5	1.0	.3
Financial Management	2.4	1.8	1.0	.2
General Accounting	2.3	2.1	1.6	.6
Industrial Organization	2.0	1.6	1.0	.9
Labor Relations	2.0	1.3	.8	.4
Management & Supervision	2.8	2.0	1.0	.4
Project Management (PERT, CPS, etc.)	2.2	2.1	1.3	.3
Marketing	1.8	1.4	.8	.2
Operations Research	1.6	1.6	.9	.2
Physical Science	1.0	1.0	.7	.3
Life Science	1.0	.9	.6	.2
Other (identify)	1.0	.6	.7	—
MATHEMATICS AND OTHER				
Algebra	1.9	2.0	1.8	.5
Trigonometry	1.3	1.9	1.1	.3
Calculus	1.2	1.2	.8	.2
Numerical Analysis	1.4	1.5	1.1	.3
Statistics	1.9	1.9	1.4	.2
Other (identify)	1.3	1.0	1.0	.4

* These data show the average ($\bar{x}$); based on the 0-4 scale shown, only of those who rated the item. These averages are therefore relevant as applicable to the respondent's operations (e.g. Unit Record Operations apply only where URO is used).

Discussion of Level of Understanding Required

In general, Analysts require the highest levels of understanding in Computer/EDP and Mathematics subject areas, but Managers or Directors require the highest levels in Business/Support subject areas. Also, as may be expected, Programmers are third in general (but highest in specific courses related to programming techniques or specific programming languages). Except for Unit Record Operations, Operators require less understanding in all listed subject areas.

In the preceding chart, generally speaking, the highest levels of understanding for Managers or Directors, Analysts and Programmers were:

Computer or EDP Related Subject Area

- Documentation Procedures
- Systems Analysis/Programming
- General Programming Techniques
- Storage & Retrieval Techniques
- Operating System Techniques
- Sort & Merge Techniques
- Specific Programming Languages, and
- Data Communications.

Business or Technical Support Subject Area

- Management & Supervision
- General Accounting
- Project Management (PERT, CPS, etc.)
- Financial Management
- Industrial Organization, and
- Economics.

Mathematics or Other Areas

- Algebra
- Statistics, and
- Numerical Analysis.

For Operators, the highest levels in the Computer Subject Area were reported for Operating Systems Techniques, Unit Record Operations, Documentation Procedures, Sort & Merge Techniques and Storage & Retrieval Techniques. The need for General Accounting was also identified.

VII. CURRICULUM OBJECTIVES

Purdue offers two curricula in Computer **Technology**; a two-year Associate Degree and a four-year Bachelors Degree. (These are in addition to the Bachelors' and Higher Degrees in Computer **Science**.) Computer-related objectives appropriate for these two curricula are listed below. Please review them, add any other you believe are important, then rank order (1st, 2nd, 3rd, etc.) in what you believe are their relative order of importance.

ASSOCIATE IN APPLIED SCIENCE
Computer Technology Program (2 yr. college level)

n = 190

Objective	Rank Order* (1 thru 12)
1. Understand computer hardware concepts and capabilities	1
2. Experience with operating a computer	8
3. Experience with unit record operations	11
4. Well-versed in the art of effective programming	2
5. Prepare program documentation, including flowcharts	3
6. Ability to program in one or more compiler languages (e.g. FORTRAN, COBOL, etc.)	4
7. Ability to program in an assembly language	7
8. Understand software concepts such as operating systems or time-sharing	6
9. Have basic concepts of data communication techniques, (e.g. remote operations, real time, etc.)	9
10. Have basic understanding of business procedures and a "business system"	5
11. Have basic understanding of the procedures and techniques of scientific and engineering problem solving	10
12. Other (identify and rank) (e.g. communicating, business practices, economics)	12

BACHELOR OF SCIENCE DEGREE
Computer Technology Program (4 yr. college level)

The following are continuing objectives met in the Baccalaureate curriculum. Please review, add any additional one, and indicate their rank order.

Objective	Rank Order (1 thru 12)
1. Capable of developing both commercial and technical programs in a number of commonly used languages	5
2. Proficient in computing, information processing, and data management techniques	1
3. Knowledgeable concerning real time data processing and data communications	8
4. Knowledgeable concerning management information systems and financial control	2
5. Knowledgeable concerning computer systems analysis in non-technical fields	4
6. Knowledgeable concerning systems programming	7
7. Knowledgeable concerning process control and other technical systems	10
8. Competent to generate a computer operating system	9
9. Experience with specific models of computer hardware	11
10. Capable of remaining current with changing technology	3
11. Possessing the potential for managing or directing EDP operations	6
12. Other (identify and rank) (e.g. management, business operations, communica[illegible])	12

* The rank order of objectives has been arranged in four columns for the convenience of the reader. The respondents' rank orderings were weighted according to the total number of employees in occupations above the key-punch operator. The unweighted (raw frequency count) rank order are essentially the same with minor variations as discussed on the following pages.

Discussion of Curriculum Objectives

The chart on the previous page shows the rank-order of objectives based on weighting each respondent's rankings according to the total number of people he employed in computer related occupations above the key-punch operator. However, it is also valuable to determine these rank orders based on unweighted -- or raw frequency responses. The comparison of the two are shown below:

Comparison of Weighted and Raw Frequency Rankings of Objectives.

ASSOCIATE IN APPLIED SCIENCE DEGREE

Objective	Rank Order* Weighted	Unweighted
Understand computer hardware concepts and capabilities	1	1
Well versed in the art of programming	2	2
Prepare program documentation, including flowcharts	3	3
Ability to program in one or more compiler language	4	5
Have basic understanding of business procedures and a "business system"	5	4
Understanding software concepts such as operating systems or time-sharing	6	6
Ability to program in an assembly language	7	7
Experience with operating a computer	8	8
Have basic concepts of data communications techniques	9	9
Have basic understanding of the procedures and techniques of scientific and engineering problem solving	10	11
Experience with unit record operations	11	10
Other	12	12

If one considers the rank orders of the unweighted and weighted sums of ranks for the overall State response to the twelve Associate Degree objectives, by employing Spearman's rank correlation coefficient method,[6/] the correlation is found to be $r_s = .986$ (which is significant at below the $\alpha = .01$ level). Thus, a high order of agreement exists between the unweighted and weighted sums of ranks. All rankings were identical or within one rank of each other.

Discussion of Curriculum Objectives (Cont'd)

Comparison of Weighted and Raw Frequency of Objectives

BACHELOR OF SCIENCE DEGREE

Objective	Rank Order	
	Weighted	Unweighted
Proficient in computing, information processing and data management techniques	1	1
Knowledgeable concerning management information systems and financial control	2	3
Capable of remaining current with changing technology	3	4
Knowledgeable concerning computer systems analysis in non-technical fields	4	6
Capable of developing both commercial and technical programs in a number of commonly used languages	5	5
Possess the potential for managing or directing EDP operations	6	2
Knowledgeable concerning systems programming	7	7
Knowledgeable concerning real time data processing and data communications	8	8
Competent to generate a computer operating system	9	9
Knowledgeable concerning process control and other technical systems	10	10
Experience with specific models of computer hardware	11	11
Other	12	12

As was the case for the Associate Degree curriculum objectives, if one considers the rank orders of the unweighted and weighted sums of ranks for the overall State response to the twelve Bachelors Degree objectives, by employing Spearman's rank correlation coefficient method[6/] the correlation is found to be $r_s = .923$ (which is significant at the $\alpha = .01$ level). Thus, a high order of agreement exists between the unweighted and weighted sums of ranks for the twelve Bachelors Degree objectives ranked by the respondents. All rankings were identical or within two of each other, except for the objective ranked 6th on the weighted side -- which was 2nd on the unweighted side.

Curriculum Objectives Comparisons
Inter-Regional

As stated earlier, mail-out addresees for the questionnaire were selected to assure representation from different divisions of industry, business, service and government, as well as from the major geographic regions of the State.

A high order of agreement was found to exist between regional responses on objectives ranking comparisons for both the Associate and Bachelor degree computer technology programs. The coefficient of concordance statistical method [6] was used for this analysis (this measure "W" ranges between 0 and 1; the nearer to 1 the better the agreement of items across rankings). The coefficients of concordance for the inter-regional rankings of the two lists of objectives are:

(a) Associate in Applied Science W = .812

(b) Bachelor of Science Degree W = .798

Each of these coefficients was found to be significant at below the .005 level. Thus, one would not expect to find this high an order of agreement by chance across regions, in less than 5 in 1,000 such matrix rankings.

In effect, this means that the rank order of these objectives as presented, can be used with a high degree of confidence in every region.

CHAPTER IV

DISCUSSION, FINDINGS, and RECOMMENDATIONS

9. Discussion, general

Computer and EDP applications are still being expanded and extensions into new areas are being made successfully. For example, monitoring and controlling industrial processes and operations are becoming more widespread.

Despite the current recession, respondents to mailed questionnaires reported they do anticipate new computer applications in the future. However, due to the flat state of the economy, it is suggested that the data from these returns be interpreted to represent the lower parameters of projected activities and requirements.

The "team approach" used in this study was found to be very helpful. An advisory committee made up of representatives from computer/EDP users in industry, business, education and government; computer manufacturers, and educators brought a variety of views and expertese to bear that otherwise could not have been realized.

Mailed questionnaires (for sample copy, see Appendix I) were mailed out with two major considerations in mind: (1) That every appropriate major industry/activity group was represented, and (2) That the main geographic regions of the State were covered. The data in this report represent these State-wide returns. The separate regional and industry data have been made available to regional representatives, and a copy of the detailed computer print-outs has been retained in the Office of Manpower Studies.

There were 1,100 surveys mailed out with 432 good responses; a response rate of nearly 40 per cent. 225 of these returns were from respondents having computer/EDP operations who completed the entire questionnaire; the other 207 returns reported there were no computer/EDP operations at their locale. Returns were from manufacturing firms; government; services (including health, education and utilities); banking, finance, insurance & real estate; wholesale and retail; and a variety of consulting, business and other activities.

The data in this report are arranged in seven major sections as follows: (1) Types of EDP Operations and Systems,

(2) Hardware, (3) Functions/Utilizations, (4) Software, (5) Manpower, (6) Levels of Understanding Required, and (7) Curriculum Objectives. These data are presented in Chapter III and Appendix II; the Discussion, Findings, and Recommendations following are also arranged in these seven sections.

10. Findings, and Recommendations for Each Major Section.

SECTION I, TYPES of COMPUTER/EDP OPERATIONS and SYSTEMS

○ Nearly 200 of the 225 firms (85%) responding who had computers or EDP systems, indicated that their local operations were complete (or total), i.e. they were not a separate part of a larger total operation. In a few instances separate operations were reported (e.g. scientific or engineering activities). This would indicate a need for trained people with broad capabilities to encompass all aspects of complete operating systems.

○ The large majority of firms (71%) reported their operations to be in the Business related area; the next largest single functional area of operations was Scientific and/or Engineering (11%), Educational and Medical Health Services and Government account for nearly all the rest. It is clear that educational and training computer technology program objectives must emphasize the Business functional area.

○ Respondents reported their basic type of EDP system to be:

	% of Returns
One or more computers at this location	47%
A combination of systems	15%
Unit Record Operations	13%
Use of service bureaus or rentals	10%
Computer here tied with computer elsewhere	7%
All others	8%
	100%

Most of the firms having one or more computers on site were those who had indicated their local operations were complete systems. A higher percentage of firms having only part operations locally, reported the use of service bureaus, rentals, or ties with computers located elsewhere.

SECTION II, HARDWARE

○ The 225 respondents having computer/EDP operations locally, reported having a total of 264 computers (the majority having one computer; others had two or more, URO, or were tied to computers located elsewhere). The majority (179) were IBM computers -- and 128 of these were 360 models, the most popular being the 360/30 (40 such models). The distribution by manufacturer was as follows:

IBM	179	RCA**	15
Honeywell*	25	Sperry Rand	6
NCR	20	Others (CDC, PRODAC, VARIAN, XDS)	4
Burroughs	16		

The over-riding popularity of the IBM 360/series models makes it clear that students preparing for the computer world-of-work must be prepared adequately to handle systems, programs and hardware related to these equipments.

○ Most of the respondents (173) reported that they used Disk Operating Systems; combinations of card-disk-tape operating systems were second (27 firms); card, or tape, or others made up the remainder.

NOTE: See Appendix II for further details on computer models, related memory-sizes, and operating systems.

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*Honeywell now includes former General Electric Computers.

**RCA no longer manufactures general-purpose computers; however, development, manufacture and marketing of specialized data communications systems and third party maintenance programs for computers and sophisticated electronic equipment will continue. 9/

SECTION III, FUNCTIONS/UTILIZATION

○ Participants in the survey were asked to indicate the present and the anticipated computer/EDP applications at their location.

The five most frequently reported present types of applications were:

(1)	Accounting/Booking	84% of respondents
(2)	Inventory Controls/Materials Management	56%
(3)	Sales Analysis/Marketing Studies	45%
(4)	Production (Planning and Control)	29%
(5)	Information Retrieval	28%

The five most frequently reported anticipated types of applications were:

(1)	Information Retrieval	29% of respondents
(2)	Decision Models/Simulation	19%
(3)	Real Time Processing (Incl. Process Control)	19%
(4)	Production (Planning and Control)	18%
(5)	Inventory Controls/Materials Management	18%

The offering of certain options in the Purdue's computer technology programs appears to be validated on the basis of the variety in reported types of operations. The needed emphasis on business-commercial applications is clear (also see second finding in SECTION I); however, the more technical, scientific/engineering functional areas are also reported and continue to increase in importance.

SECTION IV, SOFTWARE

○ The largest majority of respondents identified an extensive use of Compiler Languages (based on a frequency count of responses). The most popular was COBOL, which was used by more than 67% of the respondents -- the majority of whom reported it was increasing in importance. Although RPG or Report Writer was the second most popular compiler language (nearly 53% of respondents used it) about one-fourth of them said it was decreasing in importance. FORTRAN was the third most popular compiler language used (38%), with only a few stating it was decreasing in importance and more than one third saying its importance was increasing. PL/1 was used by nearly 18% of the respondents and was increasing in importance.

○ These data indicate the popularity and increasing importance of COBOL, a large number of firms also using RPG or Report Writer, and a growing importance of FORTRAN.

○ Assembly Languages (e.g. EASYCODER, BAL, NEAT ...) were used by more than 62% of the respondents. About half of these reported there was no change in the importance of these languages, with the remaining half almost equally divided in their views that it was increasing or decreasing in importance.

○ Operating Systems Support was also used extensively, with nearly 40% of the respondents reporting they used Job Control Languages and about 27% said they used Software Maintenance. The large majority of these users reported such systems support was definitely increasing in importance.

○ Software Program Packages (e.g. Operating systems and Applications areas) were used by about 31% of the respondents -- who were nearly all in agreement that this was increasing in importance. Special Purpose Languages (e.g. SIMSCRIPT, APT) were being used by fewer than ten per cent of those responding to this section of the questionnaire.

○ When asked what percentage of analysis and programming time was spent in the various Languages and Software, it is noteworthy that about 73% of the time was spent using Compiler Languages*; nearly 20% of the time was spent with Assembly Languages, nearly 4% in Operating Systems Support, and a little more than 2% in Software Program Packages. Fewer than 1% of the time was spent in Special Purpose Languages. The rank order of the highest average percents of time spent of those using each language were: 1st COBOL 63%, 2nd RPG or Report Writer 43%; Assembly Languages 34%, PL/1 29%, and FORTRAN 23%.

*This 73% was divided as follows: COBOL 39.1%, RPG or Report Writer 19.4%, FORTRAN 6.8%, PL/1 2.8%, with APL, BASIC, ALGOL ... making up the remaining 4.7%.

○ The high percents of distribution and utilization of analysis and programming time spent in COBOL, Assembly Languages, RPG or Report Writer in particular, as well as in FORTRAN, point up the need for educational and training programs to prepare students in or to be familiar with these languages.

The data indicate that the majority of firms utilize only a limited number -- a spattering -- of available languages and/or software.

SECTION V, MANPOWER

○ The 225 respondents having computer/EDP operations reported they had a total of 4,329 related jobs -- of which fewer than 2½ per cent were vacant. (In comparable surveys made in 1967, 9.3% of these kinds of jobs were reported as vacant.) A projected need for 2,017 personnel was estimated for the next three years. (An analysis of these data and comparisons with surveys made in 1967 point to the apparent postponement of authorizing new positions at this time -- a definite reflection of the present flat state of the economy.)

A comparison of the distribution of occupations between the 1967 and 1971 studies is shown below:

	Percent Distribution		Reported No. of Jobs
Occupational Group	1967	1971	1971
Managers/Directors	7.5%	7.1%	307
Analysts/Programmers	31.9%	30.8%	1,333
Operators/Clerical	57.8%	55.3%	2,394
Others	2.8%	6.8%*	295
	100%	100%	4,329

*Includes some jobs related to management, supervision and programming.

○ There are no statistically significant differences in the distribution of Managers/Directors, Analysts/Programmers, and Operators/Clerical between this 1971 study and the 1967 data.

NOTE: The National employment outlook for systems analysts, programmers, and electronic computer operating personnel is presented as Appendix III to this report.

The approximate annual recurring requirements for each occupation may be calculated by taking one-third of the reported needs for the next three years plus current job vacancies, then applying an expansion coefficient to inflate response results to the State universe of the industries surveyed. (Because there were a few industry groups not surveyed -- and there is a recession on -- the stated requirements should be viewed as the lower parameter of annual needs.) The survey also asked for the minimum hiring requirements for each occupation. The highlights of the results are shown in the table below:

Occupation**	Annual Recurring Needs	What are your minimum hiring requirements: Educational Level***	Previous Experience In * Years (0 For None)	With specific EDP equipment Yes	No
Manager or Director	65	Bach./Assoc.	5.2	74	70
Systems Engineer, EDP	40	Bach./Assoc.	3.8	24	13
Business Systems Analyst	175	Assoc./Bach.	3.1	37	47
Systems Programmer	120	Assoc./Bach.	2.4	58	39
Business Programmer	340	Assoc./Post H.S.	1.6	39	60
Technical Programmer	40	Assoc./Bach.	2.3	8	21
Junior Programmer (Detailer)	90	Post H.S./Assoc.	.8	14	39
Computer-Peripheral Equipment Operator	290	Post H.S,/H.S.	.9	55	71
Unit Record Equipment Operator	80	H.S./Post H.S.	.4	12	22
Key-punch or Verifier Operator	475	H.S./Post H.S.	.8	45	69
Other Data Recorders	50	H.S./Post H.S.	.4	5	25
Which Other (e.g. supervisor, EDP trainer, librarian)	120	Assoc./Bach.	2.1	26	46

*Average
**For Occupational Definitions, see Attachment A.
***Most frequently reported level is shown first.

Based on the above data (and the detailed computer print-out) it is calculated that the annual recurring needs are 125 to 150 graduates of computer technology programs at the baccalaureate level; between 800 and 900 graduates of associate degree programs; and between 900 and 1,200 personnel with some related post-high school vocational/technical training. As stated earlier, it is recommended emphasis be placed on the business/commercial options.

The above data reflect the desire of the employer to hire Systems Engineers and Systems Programmers who have had previous experience with the types of EDP equipment. This same experience requirement is not as pronounced for the other occupations, particularly for data recorders and junior programmers. (These results are statistically significant.)

SECTION VI, LEVEL of UNDERSTANDING REQUIRED

○ Respondents were asked to indicate the "level of understanding" needed in 30 subject areas for each type of occupation. These courses were homogeneously grouped under the three headings; Computer or EDP, Business or Technical Support, and Mathematics & Other. (A Likert-type 4 point scale in the cognitive domain was used.) As might be expected, Managers & Directors require the highest levels of understanding in Business/Support subject areas, and Analysts require the highest levels in Computer/EDP and Mathematics subject areas. Programmers were at a slightly lower level in the subject areas mentioned -- but were highest in specific courses related to programming techniques or specific programming languages. In general, Operators require less understanding in all listed subject areas (the one exception being Unit Record Operations).

○ As stated earlier, respondents indicated that college-level preparation was desired for Managers or Directors, Analysts, and Programmers. The rank order of the subjects selected for these occupations, arranged from highest level of understanding being first, is as follows:

1 Documentation Procedures
2 Systems Analysis/Programming
3 General Programming Techniques
4 Storage and Retrieval Techniques
5 Specific Programming Languages
6 Operating System Techniques
7 Data Communications
8 Sort & Merge Techniques
9 General Accounting
10 Management & Supervision
11 Algebra
12 Project Management (PERT, CPS, etc.)
13 Real Time Processing (including process control)
14 Statistics
15 Financial Management

For Operators, the highest levels were reported in the Computer or EDP subject area and included: Operating Systems Techniques, Documentation Procedures, Unit Record Operations, Sort and Merge Techniques, and Storage and Retrieval Techniques. The need for General Accounting was also identified.

○ It is recommended that the findings above be considered in the review of curricula of all associate and bachelors degree programs and vocational/technical courses and programs related to computer technology.

NOTE: See Section VI of Chapter III for further details of these subject ratings.

SECTION VII. CURRICULUM OBJECTIVES

Respondents were asked to rank order in importance 12 curriculum objectives for the two-year Associate Degree Computer Technology Program, and 12 objectives for the Bachelor of Science Degree Program in Computer Technology. There were 190 of the 225 respondents having computer/EDP operations who did so.

Rankings were computed based on a raw frequency count (1 "vote" per respondent), and on a "weighted" count -- which took into consideration the number of employees the respondent had in occupations above the key-punch/recorder level. The rank order of objectives for the Associate Degree are shown below, and the rank orders of objectives for the Bachelors Degree are shown on the next page.

Comparison of Weighted and Raw Frequency Rankings of Objectives

ASSOCIATE IN APPLIED SCIENCE DEGREE

Objective	Rank Order* Weighted	Unweighted
Understand computer hardware concepts and capabilities	1	1
Well versed in the art of programming	2	2
Prepare program documentation, including flowcharts	3	3
Ability to program in one or more compiler language	4	5
Have basic understanding of business procedures and a "business system" *	5	4
Understanding software concepts such as operating systems or time-sharing	6	6
Ability to program in an assembly language	7	7
Experience with operating a computer	8	8
Have basic concepts of data communications techniques	9	9
Have basic understanding of the procedures and techniques of scientific and engineering problem solving**	10	11
Experience with unit operations	11	10
Other	12	12

*The large number of firms reporting business-type functions/utilization have carried this related objective to the upper half of the list, whereas

**The comparably fewer firms having scientific/engineering applications result in this lower rank order.

However, when one considers the various options within the Computer Technology Programs, those specialized objectives which relate more closely to a particular option must necessarily be accorded a higher ranking, because most probably, the graduate will end up in a related job function.

Discussion of Curriculum Objectives (Cont'd)

Comparison of Weighted and Raw Frequency of Objectives

BACHELOR OF SCIENCE DEGREE

Objectives	Rank Order Weighted	Rank Order Unweighted
Proficient in computing, information processing and data management techniques	1	1
Knowledgeable concerning management information systems and financial control	2	3
Capable of remaining current with changing technology	3	4
Knowledgeable concerning computer systems analysis in non-technical fields	4	6
Capable of developing both commercial and technical programs in a number of commonly used languages	5	5
Possess the potential for managing or directing EDP operations	6	2
Knowledgeable concerning systems programming	7	7
Knowledgeable concerning real time data processing and data communications	8	8
Competent to generate a computer operating system	9	9
Knowledgeable concerning process control and other technical systems	10	10
Experience with specific models of computer hardware	11	11
Other	12	12

The reader is reminded that the rank order of these objectives reflects the functions and applications of the computer/EDP system operations of the rater. The high rankings of the business/commercial related objectives are consistent with the fact that most respondents reported such utilizations, with much fewer reporting the technical/scientific/engineering areas.

○ A high order of agreement was found to exist between respondents in the six regional campus (geographic) areas concerning curriculum objectives. The coefficient of concordance statistical method[6/] was used for this analysis, resulting with the Associate Degree at W = .812 and the Bachelors Degree at W = .798 (1 being perfect agreement). In effect, this means that the rank order of these objectives as presented, are applicable to all six regions.

○ It is strongly recommended that the faculty review the reported rank-ordered curriculum objectives and give them due consideration in the revision of current Associate and Bachelors' Degree programs.

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Reference Number — Title

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2. Computer and Electronic Data Processing Manpower Requirements for the Calumet, Indiana Area. Manpower Report 67-5, dated 20 Sept. 1967; School of Technology, Purdue University. 70 pages.

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7. RCA Quitting as Computer Maker; Write-off May Reach $250 Million; THE WALL STREET JOURNAL, Monday, September 20, 1971. page 2.

8. Letter of 20 August 1971 from Mr. James A. Oeffinger, of Honeywell Information Systems, Inc, 5739 Professional Circle, Indianapolis, Indiana, 46241

9. Statement issued by Robert W. Sarnoff, Chairman of the Board and Chief Executive Officer of the RCA Corporation, 17 Sept. 1971: distributed to RCA Stockholders on 20 Sept. 1971.

APPENDIX I

PURDUE UNIVERSITY
SCHOOL OF TECHNOLOGY
LAFAYETTE, INDIANA 47907

OFFICE OF MANPOWER STUDIES

SAMPLE SURVEY PACKAGE

Dear Sir:

We need your help so we can serve you better. Specifically, our associate degree (two year) and bachelor degree programs in computer technology are designed to provide graduates who will meet your needs in appropriate electronic data processing occupations. These Purdue programs are now offered at Hammond, Michigan City/Westville, Fort Wayne, and Indianapolis.

By completing and returning the attached questionnaire, we will be able to consider your requirements and reflect them in the program objectives.* Your return will be confidential and incorporated with those of other respondents; it will not be identified with your firm or organization. If you like, a summary copy of the results of the completed survey will be provided on request.

If your firm or organization has separate or autonomous data processing operations at your location, we would appreciate either one return incorporating all local EDP operations --- or separate ones from each. Additional copies of the questionnaire may be reproduced or sent to you as desired.

We hope that by working together, we may better prepare students to become effective employees, and thereby achieve successful careers.

Sincerely yours,

J. P. Lisack, Director &
Professor of Technology

ntm
encl. Questionnaire
Return envelope

* If you have no computer or EDP processing operations, please tear off and return this letter in the enclosed envelope.

Purdue University
EDP SURVEY

Please return to: Prof. J. P. Lisack
Purdue University, SCC-A
Lafayette, Indiana 47907

Name _____ Firm or Organization _____

Title _____ Address _____

_____ _____

SECTION I. TYPE OF EDP OPERATION AND SYSTEM

Please identify (√) if your return represents the total (complete) local computer/EDP operation, or a separate and/or autonomous part of the total operation at this location:

☐ TOTAL (complete) ☐ PART (separate and/or autonomous)

Please check (√) the area (s) of operations your return represents:

☐ Business

☐ Process Control

☐ Scientific and/or Engineering

☐ Other (Please identify) _____.

Please identify (√) your basic type (s) of EDP system:

☐ One or more computers at this location.

☐ Computer here tied in with computer elsewhere.

☐ Computer elsewhere with terminal facilities here.

☐ Unit Record Operations.

☐ Use of service bureaus or rental of computer time from out-of-house computer operations.

☐ Other (Please identify) _____.

SECTION II. HARDWARE

Please identify computers at your location:

Computer Manufacturer	Model	Memory Size (K)	Operating System	Remarks

SECTION III. FUNCTIONS/UTILIZATION

Please indicate (√) the present and anticipated computer/EDP applications at your location:

Present	Anticipated Within Next Three Years		Remarks
		Accounting/Bookkeeping	
		Sales Analysis/Marketing Studies	
		Inventory Control/Materials Management	
		Production (Planning & Control)	
		Real Time Processing (Including Process Control)	
		Numerical Control	
		Scientific, or Engineering Studies (Includes R & D)	
		Decision Models/Simulation	
		Information Retrieval	
		What Else? (Explain)	

SECTION IV. SOFTWARE

Please check (√) whether the languages or software you are using are increasing or decreasing in importance; then indicate your estimate of the percentage of your analysis and programming time in each:

Importance: Increasing	No Change	Decreasing	Per Cent Distribution		Remarks
				Compiler Languages: COBOL	
				FORTRAN	
				PL/1	
				RPG or Report Writer	
				Which Other* (e.g. APL, BASIC, ALGOL)	
				Operating Systems Support: Job Control Languages	
				Software Maintenance	
				Which Other*	
				Assembly Languages* (e.g. EASYCODER, BAL, NEAT)	
				Special Purpose Languages* (e.g. SIMSCRIPT, APT)	
				Software Program Packages* (e.g. Operating system & application areas)	
			100%		

*Please Identify

V. MANPOWER

Please indicate your manpower needs and minimum hiring requirements for those occupations applicable to your organization.

Occupation**	How many personnel do you:			What are your **minimum** hiring requirements:			
	Now have employed	Now have job openings for	Estimate will be needed for the next 3 years	Educational Level (Enter code number 1 thru 5*)	Previous Experience: In Years (0 For None)	Previous Experience: With specific EDP equipment: Yes	Previous Experience: With specific EDP equipment: No
Manager or Director							
Systems Engineer, EDP							
Business Systems Analyst							
Systems Programmer							
Business Programmer							
Technical Programmer							
Junior Programmer (Detailer)							
Computer-Peripheral Equipment Operator							
Unit Record Equipment Operator							
Key-punch or Verifier Operator							
Other Data Recorders							
Which Other (e.g. supervisor, EDP trainer, librarian)							

*Code: 1 – High school graduate
2 – Some post-high school training – but less than two years (non-collegiate)
3 – Associate degree (2 years college)
4 – Bachelors degree
5 – Masters or higher degree

**For Occupational Definitions, see Attachment A.

VI. LEVEL OF UNDERSTANDING REQUIRED

To what extent are understandings generally needed for each occupation?
Enter the appropriate number for each item according to the following scale:

0 – None
1 – Some Exposure (Leave blank if not applicable.)
2 – Basic Understanding
3 – Thorough Knowledge

BASIC SUBJECT AREA	Occupations: Managers or Directors	Analysts	Programmers	Operators
COMPUTER OR EDP				
Documentation Procedures				
Unit Record Operations				
Sort & Merge Techniques				
Storage & Retrieval Techniques				
Data Communications				
Real Time Processing (including process control)				
Hybrid Computers				
Operating System Techniques				
Systems Analysis/Programming				
General Programming Techniques				
Specific Programming Languages				
Simulation/Decision Models				
Other (identify)				
BUSINESS OR TECHNICAL SUPPORT				
Economics				
Financial Management				
General Accounting				
Industrial Organization				
Labor Relations				
Management & Supervision				
Project Management (PERT, CPS, etc.)				
Marketing				
Operations Research				
Physical Science				
Life Science				
Other (identify)				
MATHEMATICS AND OTHER				
Algebra				
Trigonometry				
Calculus				
Numerical Analysis				
Statistics				
Other (identify)				

VII. CURRICULUM OBJECTIVES

Purdue offers two curricula in Computer **Technology**; a two-year Associate Degree and a four-year Bachelors Degree. (These are in addition to the Bachelors' and Higher Degrees in Computer **Science**.) Computer-related objectives appropriate for these two curricula are listed below. Please review them, add any other you believe are important, then rank order (1st, 2nd, 3rd, etc.) in what you believe are their relative order of importance.

ASSOCIATE IN APPLIED SCIENCE
Computer Technology Program (2 yr. college level)

Objective	Rank Order (1 thru 12)
1. Understand computer hardware concepts and capabilities	
2. Experience with operating a computer	
3. Experience with unit record operations	
4. Well-versed in the art of effective programming	
5. Prepare program documentation, including flowcharts	
6. Ability to program in one or more compiler languages (e.g. FORTRAN, COBOL, etc.)	
7. Ability to program in an assembly language	
8. Understand software concepts such as operating systems or time-sharing	
9. Have basic concepts of data communication techniques, (e.g. remote operations, real time, etc.)	
10. Have basic understanding of business procedures and a "business system"	
11. Have basic understanding of the procedures and techniques of scientific and engineering problem solving	
12. Other (identify and rank) –	

BACHELOR OF SCIENCE DEGREE
Computer Technology Program (4 yr. college level)

The following are continuing objectives met in the Baccalaureate curriculum.
Please review, add any additional one, and indicate their rank order.

Objective	Rank Order (1 thru 12)
1. Capable of developing both commercial and technical programs in a number of commonly used languages	
2. Proficient in computing, information processing, and data management techniques	
3. Knowledgeable concerning real time data processing and data communications	
4. Knowledgeable concerning management information systems and financial control	
5. Knowledgeable concerning computer systems analysis in non-technical fields	
6. Knowledgeable concerning systems programming	
7. Knowledgeable concerning process control and other technical systems	
8. Competent to generate a computer operating system	
9. Experience with specific models of computer hardware	
10. Capable of remaining current with changing technology	
11. Possessing the potential for managing or directing EDP operations	
12. Other (identify and rank) –	

Remarks:

Purdue University

EDP SURVEY

OCCUPATIONAL TITLES AND DEFINITIONS

Manager or Director, Data Processing - Directs and coordinates planning and production activities of the EDP division. Consults with management to define boundaries and priorities of projects; discusses equipment acquisitions, determin s specific information requirements, and allocates operating time. Consults with Systems Engineer to define equipment needs; reviews project feasibility studies. Establishes work standards, assigns, schedules and reviews work. Interprets policies and goals of organization to subordinates. Prepares reports. Prepares proposals for contracting with management specialists or technical personnel to solve problems. Participates in deciding reorganization, personnel staffing and promotions within his department. Directs training of subordinates.

Systems Engineer, EDP - (Alternate titles: Computer Systems Engineer; Methods Analyst, (EDP) Analyzes EDP projects to determine equipment requirements. Confers with EDP Manager and/or Director concerning availability and capabilities of equipment in use and to specify computer system requirements for projects. Analyzes capabilities and limitations of computers and peripheral equipment in order to recommend most feasible new equipment or equipment modifications. Plans layout of computers and peripheral equipment. May specify power supply requirements, and air conditioning equipments to control temperature, humidity and dust. (May specialize in one area of equipment type or application).

(EDP) Business Systems Analyst - Analyzes business problems, such as development of integrated production, inventory control and cost analysis system, and converts it to programmable form for application to EDP system. Confers with others to ascertain specific output requirements (breakouts, summariziations, report formats); works with operating units to design and obtain standardized input data. Studies current or develops new systems and procedures to devise workflow sequence. May direct preparation of programs.

Systems Programmer - Prepares programs for the modification of and has responsibility for the mainenance of the operating system. Supervises the loading of the system. Evaluates the operations of the entire data processing system and makes changes or modifications to achieve maximum effectiveness. Works with the Systems Engineer in planning and integrating new equipments or hardware modifications.

Programmer - Converts symbolic statement of problems to detailed logical flow charts for coding into computer language and solution by means of electronic data processing; analyzes workflow charts or diagrams representing problems, applies knowledge of computers, math and logic to develop sequence of program steps. Works with others to resolve program intent, output requirements and input acquisitions, extent of auto-programming and coding use, and inclusion of internal checks and controls' prepares diagrams, observes or runs trial tests, corrects errors and compiles necessary documentation of program. Programmers who work largely with commercial (e.g. accounting and bookkeeping) operations are often called "Business Programmers." Those working with scientific and engineering operations are called "Technical Programmers."

Junior Programmer (Alternate titles; Detail Programmer or Coder) - Selects symbols from coding system and applies them to successive steps of completed program for conversion to machine processable instructions; reads and interprets alphabetic, numeric or special characters for each program step to translate into machine language or (symbolic) code; records symbols on worksheet for transfer to punch cards or machine input tape. Marks code sheet to indicate relationship of code to program steps to simplify debugging of program. Works as understudy or aide to the Programmer.

Computer-Peripheral Equipment Operator - Monitors and controls computer to process business, scientific, engineering or other data according to operating instructions. Mounts and positions materials. Sets control switches on computer and peripheral equipment for their integration and operation according to program, routines, and specified data requirements. Selects and loads input and output units (i.e. tapes or punch cards) for operating runs, or oversees Peripheral Equipment Operator's work. Observes operations for errors or faults. Types alternate commands into computer console according to instructions to correct error or failure; notifies supervisor of errors or stoppage. Clears unit, reviews schedules, records operating and down time. May operate machines that convert cards to tape or vice versa or high speed printers.

Tabulating-Machine Operator (Unit Record Operator) - Operates machine that processes data from tabulating cards into printed records. Wires and installs plugboard (control panel) or inserts pre-wired panel. Processes cards through machine, may file or route processes cards to next station. May tend sorting, interpreting, reproduction or collating machine.

Key-Punch or Verifier Operator - Operates key-punch machine to transcribe data from source material onto punchcards and produce prepunched data; verifies registration of punches. May tend machines that sort, merge or match punchcards. Verifies accuracy of data punched on tabulating cards, removes incorrectly punched cards; may punch corrected cards.

Data Typist (Other Data Recorders) - Converts alphabetic, numeric and symbolic data into coded form on punchcards or tapes; loads cards or tapes into machines to produce desired cards or tapes. Types computer programs and input data, proofreads typed copy; may operate automatic duplication equipment.

DO NOT RETURN THIS PAGE OF OCCUPATIONAL DEFINITIONS.

APPENDIX II

COMPUTER MANUFACTURERS and MODELS, with RELATED MEMORY SIZES and OPERATING SYSTEMS*

APPENDIX IIA-- Models and Memory Sizes

MANUFACTURER and MODEL	MEMORY SIZE (K)										
IBM	TOTAL	4/8	12/16	20/24	32/48	64/65	128/131	160/192	256	384/512	512+
Model 360/20	26	12	13	1							
Model 360/25	14		3	3	7						
Model 360/30	40		1		12	27					
Model 360/40	19					2	11	3	3		
Model 360/50	24					6	1		9	8	
Model 360/65	5									1	4
Model 1130	13	10	2			1					
System-3	10	2	6	2							
1401	8	7	1								
Others[1]	20	3	—	1	2	3	—	2	—	1	3
Totals	179	34	26	7	21	38	12	5	12	10	7

HONEYWELL	TOTAL	1	4	8	12	16	20	24	28	32	40 / 42	49	65
Model 120	8		1	2	1		1	1		1			1
Model 200	5							1	2		1	1	
Others[2]	12	1	—	1	3	3	—	—	—	2	1	—	1
Totals	25	1	1	3	4	3	1	2	2	3	2	1	2

NCR	TOTAL	10	16	20	32	65	80
NCR 315	9	6		2			
Century 100	6		2		4		
Century 200	5				2	3	
Century 400	1	—	—	—	—	—	1
Totals	20	6	2	2	6	3	1

[1] Other IBM models include: 4 (each) 370/155, 2-7090/94, 2-1620, 1-1051, 1-1052, 1-1056, 1-1360/20, 1-1440, 1-1710, 1-5410, and others.

[2] Other Honeywell models include: 3-115, 2-110, 1-415, 1-615, and 1-1250; plus former G. E. models 2-G115, 1-225, and 1-425.

*As reported by 225 Indiana firms having computer/EDP operations.

APPENDIX IIA (continued)

MANUFACTURER and MODEL	MEMORY SIZE (K)										
RCA	K TOTAL	8	16	20	49	65	128	131	252	262	524
Model 70/45	6						1	1	2	2	
Others[3/]	9	2	1	2	1	2	—	—	—	—	1
Totals	15	2	1	2	1	2	1	1	2	2	1

BURROUGHS	K TOTAL	1	2.4	9.6	19.2	100	110	120
Models[4/]	16	5	1	3	1	2	1	2

SPERRY-RAND	K TOTAL	8	12	16	32	65
Models[5/]	6	1	1	1	1	1

OTHERS	K TOTALS	4	8	98
Models[6/]	4	1	2	1

OVERALL TOTALS 262

3/ Other RCA models include: 2-70/15, 2-501, 2-301, 1-70/35, 1-70/60, and 1-1600.

4/ Burroughs models include: 4-3500, 2-300, 1-280, 1-283, 1-TC-500, 1-506, 1-2502, 1-E4000, 1-E8000, and others.

5/ Sperry-Rand models include: 2-9200, 1-9300, 1-9400, 1-1004, and others.

6/ Other models include: CDC, PRODAC, VARIAN, and XDS.

APPENDIX IIB. Models and Operating Systems

MANUFACTURER and MODEL	OPERATING SYSTEMS/S*						
IBM	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Model 360/20	8		5		3	2	8
Model 360/25	1	1	10		1		1
Model 360/30			37	2		1	
Model 360/40			19				
Model 360/50			5	13			6
Model 360/65			1	5			
Model 1130			5		3		5
System-3	3		7		2		
1401	2				2	1	4
Others[1]	3	—	4	6	2	1	5
Totals	18	1	92	26	13	5	29
HONEYWELL	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Model 120	3	1		1	3		
Model 200		2			2		1
Others	1	2	5	—	3		2
Totals	4	5	5	1	8		3
NCR	COS	TOS	DOS	OS	OTHER	NONE	N/R**
NCR 315		4			1		3
Century 100			3		1		2
Century 200			2		2		1
Century 400		—	—		1		—
Totals		4	5		5		6

[1] Other IBM models include: 4(each) 370/155, 2-7090/94, 2-1620, 1-1051, 1-1052, 1-1056, 1-1360/20, 1-1440, 1-1710, 1-5410, and others.

[2] Other Honeywell models include: 3-115, 2-110, 1-415, 1-615, andl 1-1250, plus former G. E. models 2-G115, 1-225, and 1-425.

*COS - CARD OPERATING SYSTEM
TOS - TAPE OPERATING SYSTEM
DOS - DISK OPERATING SYSTEM
OS - COS U DOS U TOS (Combinations)

**N/R - Non-Response

APPENDIX IIB (Continued)

MANUFACTURER and MODEL — OPERATING SYSTEMS/S*

RCA	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Model 70/45		5	5		1		
Others[3]	2	1	2		6		
Totals	2	6	7		7		

BURROUGHS	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Models[4]					7	6	3

SPERRY-RAND	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Models[5]	1	1	2		1		1

OTHERS	COS	TOS	DOS	OS	OTHER	NONE	N/R**
Models[6]					1	1	2

OVERALL TOTALS	COS	TOS	DOS	OS	OTHER	NONE	N/R**
	24	17	171	26	41	12	44

[3] Other RCA models include: 2-70/15, 2-501, 2-301, 1-70/35, 1-70/60, and 1-1600.

[4] Burroughs models include: 4-3500, 2-300, 1-280, 1-283, 1-TC-500, 1-506, 1-2502, 1-E4000, 1-E8000, and others.

[5] Sperry-Rand models include: 2-9200, 1-9300, 1-9400, 1-1004, and others.

[6] Other models include: CDC, PRODAC, VARIAN, AND XDS.

*COS - CARD OPERATING SYSTEM
TOS - TAPE OPERATING SYSTEM
DOS - DISK OPERATING SYSTEM
OS - COS U DOS U TOS (Combinations)

**N/R - Non-Response

APPENDIX III

EMPLOYMENT OUTLOOK (NATIONAL) for PROGRAMMERS, SYSTEMS ANALYSTS, and ELECTRONIC COMPUTER OPERATING PERSONNEL

Programmers. Many thousands of new jobs for programmers will become available each year through the 1970's. Employment is expected to increase very rapidly, as an expanding and increasingly complex economy causes computers to become more useful to business and government, and as the number of computer installations also rises rapidly. The increase in employment is expected to be particularly sharp in firms which use computers to process business records or to control manufacturing processes.

The rise in employment could well be accompanied by changes in the nature of the work done by programmers. Advances in programming techniques and equipment, such as "automatic programming" and the use of programs and program parts stored in libraries for future reference, will eliminate much of the routine work associated with writing a program. As a consequence, professionally trained personnel qualified to handle both programming and systems analysis are likely to be increasingly in demand, especially for work on scientific and engineering problems. For other positions, many of them in large business offices where the analysis is done by accountants and other subject matter experts, there is some evidence that 2 years of intensive training at the post-high school level may provide a sufficient background for beginning programmers.

Most of the openings for programmers in the years just ahead will be new jobs that arise as the number of computer installations continues to increase, and computers are put to new uses. Some openings also will occur as programmers advance to more responsible positions, or as they leave their jobs to enter other types of employment. Because this occupation includes many comparatively young workers, fewer positions are likely to become vacant because of retirement or death than in other occupations of similar size.[5/]

Systems Analysts. Employment opportunities for systems analysts should be excellent through the 1970's. Systems analysts ranked among the fastest growing professional occupations in recent years. Employers have experienced difficulty in recruiting qualified systems analysts because of the demand for people with similar backgrounds especially from the science and mathematics fields.

A growing demand for systems analysts will result from the rapid expansion occurring in the number of electronic data-processing systems used by businesses, government agencies, and other organizations. Additional opportunities for systems analysts will arise as computers and peripheral equipment become more sophisticated and are made capable of solving more complex problems in a wider variety of fields. Greater emphasis will be placed on developing computer systems which will retrieve information more efficiently and economically; solve complex business, scientific, and engineering problems; and monitor and control industrial processes. These developments and others, such as the extension of computer technology to small businesses, the use of systems analysts in market research and in determining the locations of plants and stores, and the growth of computer centers to serve individual clients on a fee basis, signify a very rapid rise in future employment levels of systems analysts.

In addition to the many employment opportunities resulting from growth in the field, some openings will occur as systems analysts advance to more responsibility positions or leave their jobs to enter other types of employment. Because many of the workers are young, relatively few positions will be available because of retirement or death.[5/]

Electronic Computer Operating Personnel. A growing and increasingly complex economy is expected to cause the use of electronic data-processing equipment to continue to increase very rapidly through the 1970's. Computers are being adapted to new uses almost daily, and, as the tasks they perform become even more varied, many more business firms will be utilizing them. Although the size of the staff required to operate a computer installation may be reduced somewhat as new types of equipment are developed, the total number of computer and auxiliary equipment operators is expected to increase very rapidly.

Thousands of operators will be needed to fill new jobs, both in firms having their own computer installations and in service centers which rent computer time to businessmen. Many operators also will be needed to replace operators of computer systems who transfer to other kinds of work or stop working. As in the past, employers will fill some positions by training people already in their employ, but many others will be filled by hiring outsiders.

The equipment changes which are expected in computers also may produce changes in job requirements for console and auxiliary equipment operators. Because of advances in technology, much of the equipment in use today is far less complex to operate than the first computers of the early 1950's; and future changes may bring further simplification. As a consequence, newcomers to this field may find it easier to qualify for the openings available than have applicants in the past.[5/]

BIBLIOGRAPHY OF MANPOWER STUDIES AND REPORTS

School of Technology, SCC-A
Purdue University
Lafayette, Indiana 47907

Office of Manpower Studies
Director, Professor
J. P. Lisack

MANPOWER REPORT NUMBER — TITLE AND DESCRIPTION

65-3 - Technician-Level Educational Planning for the Chemical Technology in Indiana, 20 Oct., 1965. Examines industries related to the Chemical technology. Presents scientists, engineers and technicians as a percent of total employment in major industries. Explains methods of computing technician requirements by industry and locale. Includes occupational titles and sample chemical technology.

66-1 - Technician-Level Educational Planning in the Greater Lafayette, Indiana Area, Concerning the Electrical/Electronic Technology, January, 1966. Determines numbers of technicians needed annually in industries employing electrical/electronic type technicians. Examines ten year trends in local employment and projects requirements into future. Discusses occupations concerned, orientation of educational programs, curricula, and collateral items.

66-3 - Occupations, Qualifications, and Areas of Work in Architectural, Construction and Related Fields for Jobs Above the Skilled Craftsman Level, 10 March, 1966. Describes selected occupations to assist faculty concerned with determining requirements for and objectives of related educational programs. Occupational titles, definitions and qualifications are shown with required education, vocational preparation, and aptitudes.

66-4 - Foundry Technicians and the Foundry Industry in Indiana, 30 March, 1966. Examines the foundry industry, manpower requirements, and the kind of educational program needed - for foundry technicians. National manpower factors are corroborated in a survey of 125 Indiana foundries: survey respondents' opinions of educational needs (by subjects and courses) are included.

66-7 - Selected Technical Education Needs in Howard County, Indiana, "The Kokomo Study," 1 August, 1966. Examines manpower, industry and economic factors to identify kinds and levels of post-high school technical educational programs that may be needed. Presents results of survey wherein the needs for these identified programs are verified. Describes methods and instruments used.

66-9 - Region One Manpower Study. (N.W. Sector of Indiana) 18 October, 1966. This report is a projection - ten years into the future - for seven counties. It includes estimated changes in employment by industry and changes within occupational groups. Has special notes on needs for initial and continuing education, and on rising hiring standards.

66-10 - Manpower and Training Needs in Fluid Power, 30 November, 1966. Contains (1) Specific manpower requirements at five occupational levels in fluid power technology - with factors applicable to various major industry groups; (2) Types of educational courses needed; (3) The depth of understandings required at each occupational level in fluid power courses, and supporting technical and other courses; (4) Comments of representatives from Indiana industries. Includes methods and questionnaire used.

67-1 (Indianapolis); 67-3 (Calumet); and 67-4 (Fort Wayne) - Manpower Requirements for Industrial Illustrators and Draftsmen, (thru August, 1967). A series of reports for metropolitan areas indicated containing: (1) Background data re needs, employment, and salaries of technicians and draftsmen; (2) Occupational descriptions, qualifications, education and training for draftsmen and for industrial illustrators; (3) Results of surveys to determine current and future needs and training program information; (4) Discussion of the impact of future technological changes on the drafting processes - and their effects on draftsmen qualifications. The hypothesis is made - and proven- that greater work complexity and advances in technology affecting the drafting processes, have made the utilization of Tracers less profitable; Job entry level is moving to the higher level of Detailer having better educational preparation.

67-2 (Indianapolis); 67-5 (Calumet); 67-6 (Fort Wayne); 68-1 (Kokomo) - Computer and Electronic Data Processing Manpower Requirements, (thru March, 1968). Reports results of research and surveys for metropolitan areas indicated concerning: (1) Background info re computers; (2) Job descriptions and qualifications of 23 computer and EDP occupations; (3) Numbers of people employed, current job vacancies and projected requirements; (4) Types of equipments and nature of computer applied functions; (5) Training and educational programs; and (6) Ratios of computer jobs to total employment and job categories.

67-7 - Requirements for Personnel Staff Members and Supervisors, 28 December, 1967. Report contains factors - or ratios- of personnel staff members to total employees in each industry group. The past, present, and projected ratios and trends are developed for first-line supervisors (viz. foremen):

e.g., In 1952, there were 29 employees for each supervisor,
in the early 60's there were 20 employees per supervisor,
in 1967, there were 18 employees per supervisor, and
by 1972, there may be only 15 employees per supervisor.

The annual recurring losses, growth factors, and educational ramifications are described. Factors are applied to industries in the Northeast Region of Indiana.

68-2 - Indiana's Need for Assistants in Veterinary Medical Practice, 15 May, 1968. Study points out the needs for, identification of, description, education and control of auxiliaries to the professional veterinarian. Results of a survey of all practicing veterinarians in Indiana are presented. Report includes: (1) Titles, descriptions, duties and qualifications of animal technicians, small animal hospital attendants, livestock health attendants, and others; (2) The numbers of these auxiliaries now employed, current job vacancies, and future requirements; (3) Salary and training matters; (4) The need for licensure or registration, and methods to be used; (5) Comments of veterinarians; and (6) Related Conclusions and Recommendations.

68-3 - Study of Computer Use in Medium-sized Manufacturing Firms, 1 August, 1968. This study examines the utilization of computers by medium-sized manufacturing concerns engaged in the fabrication of non-durable materials or light weight durable materials. Sampling techniques were used to acquire data from companies throughout the U.S. and a five-state midwest region by mail, plus a telephone interview with a special sample of midwest companies. The study includes: usage of EDP equipment, utilization by functional areas, estimated efficiency and dollar return on computer investment, manpower requirements and training and salary matters, major problem areas encountered and summaries of the survey findings. A review of pertinent literature is also reported in the study.

68-4 - A Proposed Land Surveyor Baccalaureate Program and the Need for Land Surveyors in Indiana, 15 Semptember, 1968. The purpose of this study is to provide data and recommendations concerning land surveyors in Indiana. This report contains the types of surveying services performed, present employment, job vacancies, and the projected requirements for land surveyors. Data was acquired through questionnaires sent to all County Surveyors, the State Highway Commission and other government offices, to private practice surveying firms and to selected firms in industry. The study establishes that substantial present and projected needs exist for land surveyors, and provides data and information useful for related curriculum development.

A proposed baccalaureate curriculum designed for professional land surveyors is included. Survey respondents indicated a favorable attitude towards the proposed program, gave some constructive suggestions, and indicated they were willing to hire graduates at reasonable salaries. The requirements for State Registration of professional land surveyors are also discussed.

69-1 - Manpower Requirements for Pollution Control and Water Resources in Indiana and a Related Pollution Control Technology Curriculum, 24 Feb., 1969. Indiana is no different than most States in the need to cope with mounting problems in air and water pollution control, liquid and solid waste disposal, water resources and allied fields. At the core of many of these problems is the lack of engineers, professionals in physical and life sciences and technicians: this study identifies these occupations and presents current employment and job vacancies, and projected requirements. Manpower data is obtained through an extensive survey of manufacturing industries, water and wastewater plants, government and educational agencies. The hypothesis is made and supported by data that a single curriculum of selected technical courses is common to variety of related technician-level occupations. A proposed two-year associate degree program for pollution control technology and survey respondents' reactions to the curriculum, their willingness to hire graduates, and estimated salary information are included. Related matters of operators and technicians examination, certification or registration are discussed.

69-2 - Air Traffic Control and Flight Service Specialists in Indiana, 23 June, 1969. Describes duties and functions of these specialists, working conditions, and current and projected requirements. Discusses need for providing a sufficiently broad educational base to assure continuing job proficiency and professionalism, ability to apply latest technological developments, and to advance or move successfully into other related occupations. Provides recommendations for educational program development.

69-3 - The Case for Library Technical Assistants and Library Clerks in Indiana, 18 September, 1969. The purposes of this study were to identify the roles of these supportive personnel (as approved by the American Library Association), to determine their acceptance by practicing professional librarians, and to ascertain the present and projected needs in the School, public, college/university, and special libraries in Indiana. Study includes estimated monthly salaries, certification matters, courses needed in training programs, and related views of librarians. Data were obtained from extensive surveys: study was conducted under auspices of a professional library advisory committee.

70-1 - 75,000 High School Seniors; Their Educational and Vocational Plans. Results of a Survey of Indiana's High School Senior Class of 1969. 30 April, 1970. This study presents the results from questionnaires returned by more than 46,500 seniors who reported their plans after graduation from high school. Included are the type of high school programs they were enrolled in and their grade average, the size of the communities they live in, the occupation and educational level of the head of household, and the vocation or profession they hope to enter. Also shown are their plans for school or employment immediately after graduation, when they made their choices and who influenced them most. Comparisons of selected variables and inter-relationships (such as grade average vs. educational or employment plans) are included. Highlights are shown.

70-2 - Foremen in Indiana Industries, Their Characteristics, Work Functions and Training Requirements, 30 October, 1970. The purposes of this study are to identify some key characteristics concerning foremen which include:

Their years of experience as foremen, their age and educational level;
Their current areas of work and the most important functions of their job;
The subject areas where they need additional knowledge (training);
The subject areas they believe are essential in the training of new foremen;
What kinds of courses they would participate in, how much time they would be willing to spend, and what portion of costs they would be willing to pay.

The study also verifies ratio of workers to foremen, as well as identifies types of foremen training programs now being used - and new programs needed - as reported by Indiana firms. The willingness of firms to participate in planning and sharing costs for specific types of foremen training programs are presented. The basis for a unique, flexible two year associate degree program for professional foremen is developed in this study, which recognizes the different requirements of various firms and foremen.

Data were acquired thru an extensive State-wide survey with questionnaire answers and suggestions from more than 4,000 individual foremen and 325 firms of various sizes in all industries. This study was conducted with the assistance of the Indiana Manfacturers Association, the American Society of Foremen and members of an advisory committee made up of representative foremen and managers in industry and educators.

71-1 - Trends in Indiana High School Seniors' Education and Vocational Plans; Comparisons of the Classes of 1966 and 1969. 28 February, 1971. There have been two attempts in the recent past to acquire detailed information about the characteristics and plans of high school seniors. One of these is reported on the preceding page as Manpower Report 70-1, 75,000 High School Seniors... which surveyed the Class of 1969. Another comprehensive study was completed earlier of the Class of 1966. This manpower report (71-1) compares these classes and among other findings reports that: Most seniors in both classes were enrolled in College Prep. or General Educ. type programs; 6% were A average students, about 35% were B, 48% were C, 4% were D, others reported "unknown"; most of these students planned to continue their education or enter a training program; fewer in the '69 Class planned to enter the military (growing unpopularity with the Viet Nam War perhaps?); more of the '69 Class planned occupations in Health and other human services--fewer in Engineering and skilled manufacturing trades; more planned to work full or part-time (effects of depressed economy being reflected perhaps?) and others. Highlights are presented throughout the report.

71-2 - Veterinary Medical Manpower Trends in Indiana, With Some National Comparisons, 15 July, 1971. This manpower report records the numbers and trends of veterinarians for over a century of time in the United States as a whole and in Indiana. The ratios of dogs & cats, and of horses to people are compiled: the numbers and the ratios of veterinarians to the U.S. population (human), to dogs & cats, and to livestock (horses & mules, cattle and hogs) are also calculated and charted. Comparisons are made of the National data and trends with those of Indiana. Sources of information are carefully documented.

Also shown for Indiana are the early colleges of veterinary medicine (circa 1890-1920), the distribution of veterinarians by area (type) of practice, and information about the School of Veterinary Science and Medicine at Purdue and its graduates. Registration is discussed and projections are made.

The highlights of the report are presented in convenient form at the end of the report.

NOTE: Copies of these reports are available for $2.00 per copy (Indiana Government and Educational Offices exempted). Please make check payable to Purdue University.

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